

*Obainia gabonensis* n. gen., n. sp.  
and *Rhigonema pachyboli* n. sp.  
(Rhigonematidae, Nematoda)  
from *Pachybolus* sp.  
(Pachybolidae, Spirobolida, Diplopoda, Myriapoda)  
in Gabon

by Martin L. ADAMSON

**Abstract.** — The rhigonematids *Obainia gabonensis* n. gen., n. sp. and *Rhigonema pachyboli* n. sp. are described from the posterior intestine of *Pachybolus* sp. from Gabon. The genus *Obainia* is similar to *Rhigonema* in that the anterior end of the oesophageal corpus is guarded by three sclerotized toothed cuticular jaw-like formations. *Obainia* is distinguished from *Rhigonema* in having a dorsoventrally elongate oral opening and a highly reduced dorsal jaw piece. *Obainia gabonensis* possesses two extremely unusual features : large lateral muscle masses composed of two to ten apparently coelomyarian subunits, present only in males ; submedian hypodermal cords, present only in females. *Rhigonema pachyboli* n. sp., most similar to *R. neyrae*, is distinguished in having 25 rather than 23 caudal papillae and by the fact that these are asymmetrically distributed : one median, 13 on the right and 11 on the left side of the body. *Dudekemia* Artigas, 1930, and *Ruizia* Travassos and Kloss, 1959, are considered synonyms of *Rhigonema*. *Rhigonema* consists of two evolutionary lines as revealed by disposition of caudal papillae : one in Africa and India which gave rise to *Obainia* and one in North and South America and the Pacific region.

**Résumé.** — Description de deux nouveaux Rhigonematidae, *Obainia gabonensis* n. gen., n. sp. et *Rhigonema pachyboli* n. sp., parasites de l'intestin postérieur de *Pachybolus* sp. au Gabon. Chez le genre *Obainia*, comme chez le genre *Rhigonema*, l'extrémité antérieure du corpus œsophagien est munie de trois pièces sclérotisées en forme de mâchoires denticulées. *Obainia* se distingue de *Rhigonema* par une ouverture buccale allongée dorso-ventralement et une mâchoire dorsale fortement réduite. *Obainia gabonensis* possède deux caractères tout à fait originaux : de larges masses musculaires latérales composées de deux à dix unités apparemment coelomiales, présentes seulement chez les mâles ; des cordes hypodermiques submédianes présentes seulement chez les femelles. *Rhigonema pachyboli* n. sp. est très proche de *R. neyrae*, mais s'en distingue par la présence de 25 papilles caudales au lieu de 23, et par la disposition asymétrique de ces papilles : une médiane, 13 à droite et 11 à gauche. *Dudekemia* Artigas, 1930, et *Ruizia* Travassos et Kloss, 1959, sont mis en synonymie avec *Rhigonema*. Le genre *Rhigonema* comprend deux lignées évolutives qui se distinguent par la disposition des papilles caudales : une lignée qui a évolué en Afrique et aux Indes et a donné naissance au genre *Obainia* et une lignée qui a évolué dans le Nouveau Monde et dans la région Pacifique.

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Many parasitic nematodes belonging to at least six species were collected from the posterior intestine of a female *Pachybolus* sp. (Pachybolidae, Spirobolida, Diplopoda) from Gabon. Among the species were two members of the Rhigonematinae *sensu* Theodorides, 1965, namely, *Obainia gabonensis* n. sp., n. gen. and *Rhigonema pachybolii* n. sp. These two species are described here ; the other species will be the subject of a future communication.

#### MATERIALS AND METHODS

The host was identified by Dr. J. P. MAURIÈS, Laboratoire des Arthropodes, Muséum national d'Histoire naturelle. Nematodes were fixed in hot 70 % ethanol and stored in 70 % ethanol before being cleared and examined in lactophenol. Types are stored in the parasite collection of the Muséum national d'Histoire naturelle, Paris (Laboratoire des Vers, RA 34).

Portions of *O. gabonensis* n. sp. were embedded in paraffin, sectioned at 5  $\mu$ m, and stained with Masson's Trichrome (MARTOJA and MARTOJA, 1967) to study the structure of the somatic musculature.

#### RESULTS

##### **OBAINIA** n. gen.

Rhigonematidae, Rhigonematinae *sensu* Theodorides, 1965. Mouth opening dorsoventrally elongate. Oesophageal corpus short and stout, its anterior end with one small dorsal and two large lateral sclerotized toothed jaw-like structures. Egg with thick, smooth, inflexible shell. Parasites of african diplopods.

TYPE SPECIES : *Obainia gabonensis* n. sp.

##### **Obainia gabonensis** n. sp.

(Figs. 1-3)

Large worms with blunt cephalic and conical caudal extremities. Cephalic extremity slightly elongate dorsoventrally. Body cuticle at anterior extremity smooth, consisting of cephalic cap surrounding mouth opening and short posterior collar separated from cephalic cap by groove. Cephalic cap divided into two subdorsal lobes, two much larger lateral lobes and one small ventral lobe.

Cephalic sense organs consisting of four prominent round papillae, one on each subdorsal and lateral lobe and each with large central and smaller eccentric nerve ending, and two amphids just posterior to cephalic cap.

Body cuticle posterior to cervical collar with fine striations about 2  $\mu$ m apart ; each stria with tiny posteriorly directed cuticular spines which diminish in size posteriorly.

Buccal cavity short, lined with body cuticle. Anterior end of oesophageal corpus attached to body cuticle laterally by bundles of fine filaments. Oesophageal lumen sub-

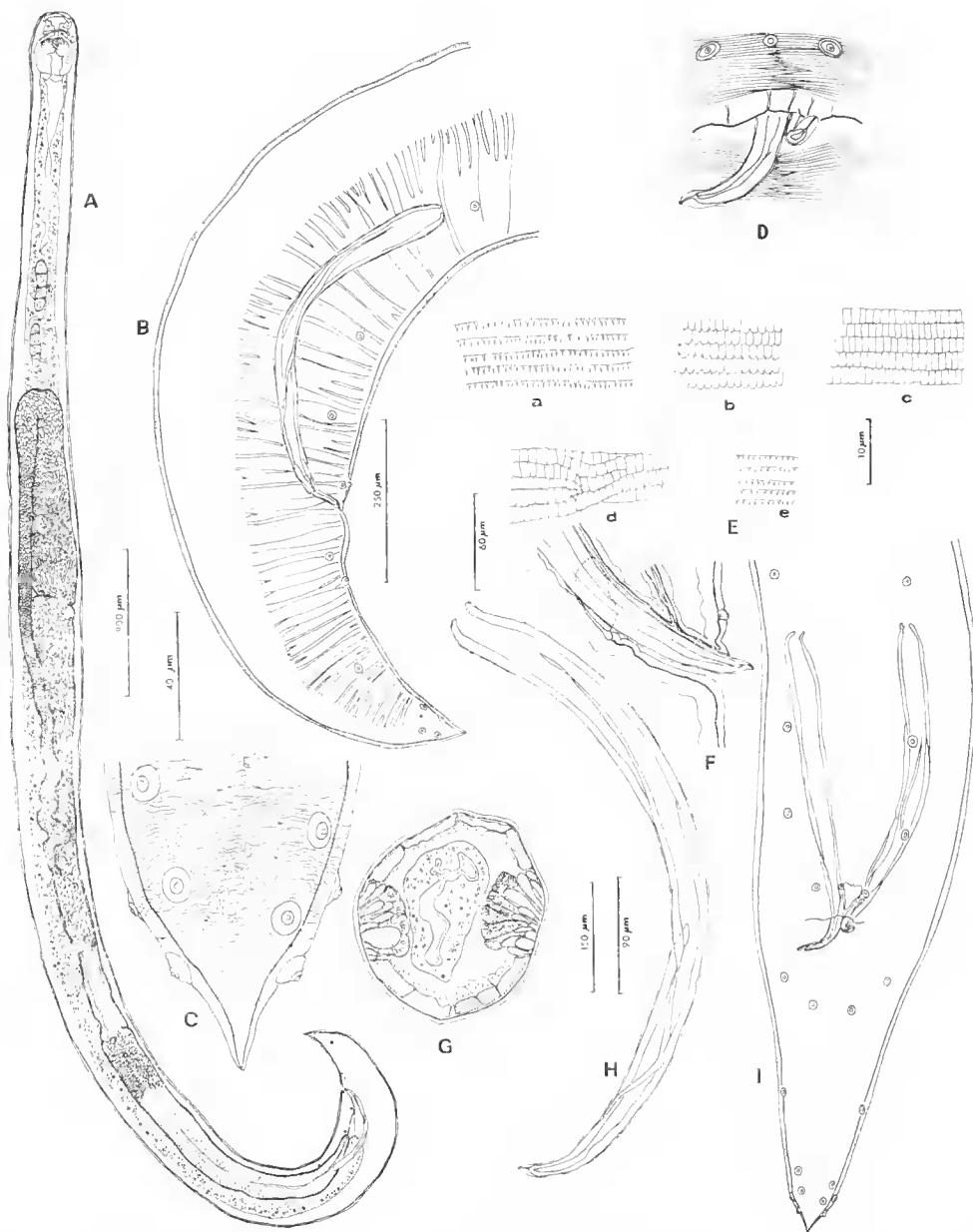


FIG. 1. — *Obainia gabonensis* n. gen., n. sp. A, male entire, lateral view. B, caudal extremity of male, lateral view. C, tip of tail of male, ventral view. D, male, anal region, ventral view. E, cuticular ornamentation: a, near level of base of oesophagus, male; b, near level of flexure of testis, male; c, near level of seminal vesicle, male; d, lateral region near midbody, male; e, female, posterior region of body. F, male, lateral view of anal region. G, male, transverse section through midbody region. H, left spicule, lateral view. I, caudal end of male, ventral view. (A : 800 µm scale; B and I : 250 µm scale; C : 40 µm scale; D and F : 60 µm scale; E : 10 µm scale; G : 150 µm scale; H : 90 µm scale.)

triangular in cross-section, its cuticular lining with one dorsal and two subventral striated swellings just posterior to jaws. Oesophageal bulb extremely well-developed with prominent sclerotized valve plates.

Excretory system H-shaped with inconspicuous pore leading through vesiculate terminal duct to transverse canal which divides on either side into anterior and posterior lateral canals.

Coelomocytes consisting of two groups of four cells *in tandem* just anterior to anterior limit of reproductive tract.

### *Male*

Cuticular spines on body cuticle gradually changing to small rounded scales posteriorly and disappearing completely in posterior half of body. Cuticle at posterior end of tail ornamented with irregular system of wrinkles.

Two lateral and two median hypodermal cords present. Somatic musculature platymyarian except for one pair immediately ventral to lateral fields beginning just posterior to base of oesophagus and ending just anterior to spicules; this pair consisting of two to ten apparently coelomyarian subunits, displacing hypodermis and filling lateral fields in midbody region.

Reproductive system J-shaped. Testis, its blind end in posterior half of body running anteriorly, flexing posteriorly and expanding into large chamber filled with elongate spermatozoa. Seminal vesicle lined with columnar epithelium and separated from testis by constriction. Vas deferens glandular.

Spicules similar, subequal and arcuate. Gubernaculum poorly cuticularized, lying between spicules.

Twenty three caudal papillae: four pairs subventral pre-anal; one median unpaired just anterior to anus; five pairs subventral and two pairs dorsolateral postanal. Phasmids between secondlast pair of subventral and second last pair of dorsolateral papillae.

### *Female*

Cuticular ornamentation consisting of rows of spines becoming smaller posteriorly but continuing into caudal region.

Didelphic; amphidelphic. Vulva of inseminated females plugged by amber colored plate-like formation. Vagina muscular, directed anteriorly and expanding to form large chamber before narrowing abruptly, flexing posteriorly and dividing into anterior and posterior uterine branches. Eggs in uteri with smooth shells 6 to 9  $\mu\text{m}$  thick containing embryo in one to eight cell stage.

Somatic musculature platymyarian, without specialized lateral muscles. Two lateral, two median and four submedian hypodermal cords present; submedian cords beginning just anterior to anterior flexure of reproductive tract and ending posterior to posterior flexure of reproductive tract.

**DIMENSIONS:** *Male* (holotype followed by range of 3 paratypes in parentheses): Length 8.76 (9.21-9.65) mm. Maximum width 365 (354-404)  $\mu\text{m}$  near midbody. Buccal cavity 12 (9-11)  $\mu\text{m}$  and oesophageal corpus 142 (143-155)  $\mu\text{m}$  long. Bulb 216 (221-234)  $\mu\text{m}$  long and 230 (224-248)  $\mu\text{m}$  wide. Nerve ring 135 (131-139)  $\mu\text{m}$  and excretory pore 138 (139-168)  $\mu\text{m}$  from anterior extremity.

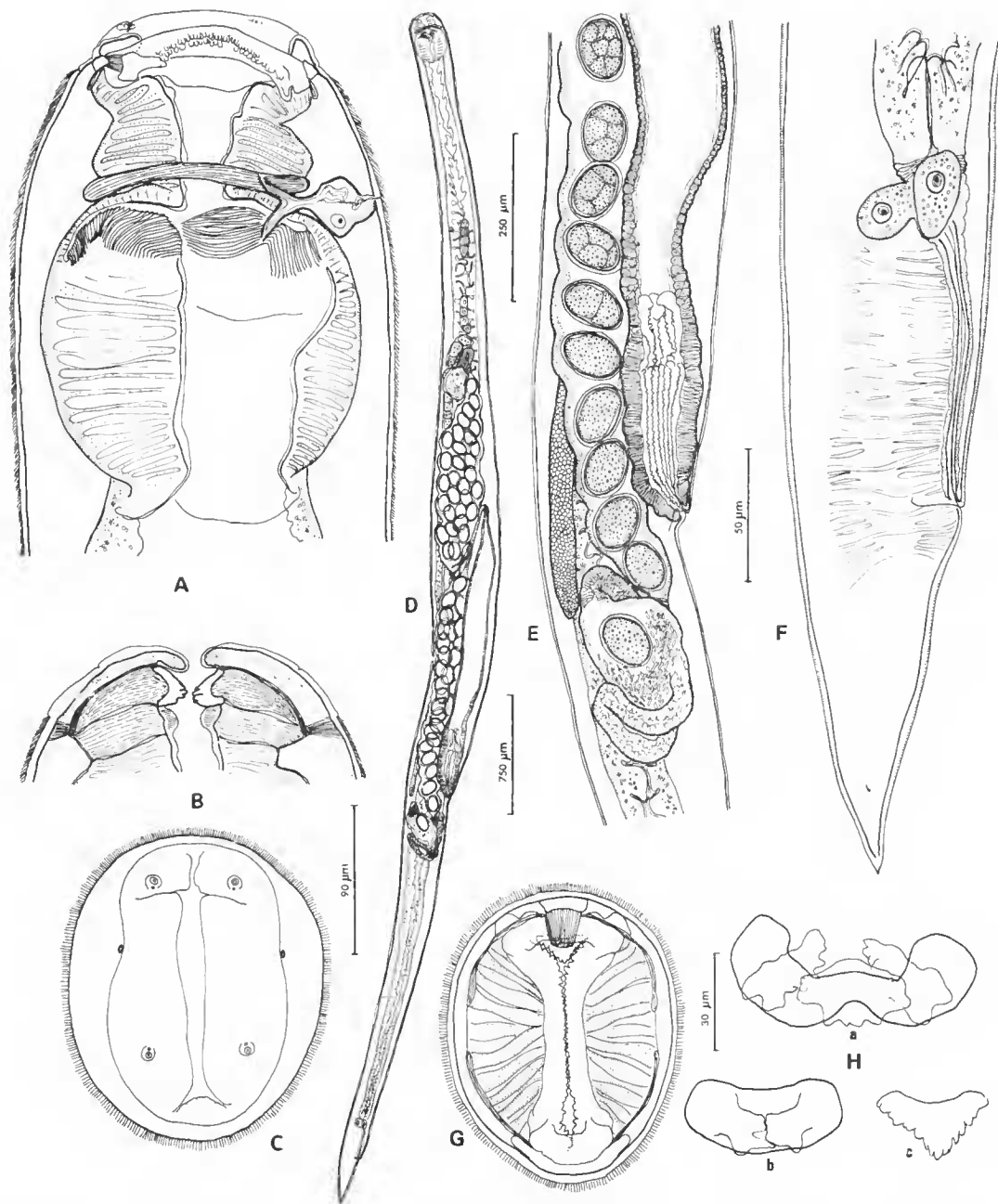


FIG. 2. — *Obainia gabonensis* n. gen., n. sp. A, oesophageal region of male, lateral view. B, optical section through cephalic extremity of male, ventral view. C, apical view, male. D, entire female, lateral view. E, vulva region, lateral view. F, caudal region, female, lateral view. G, section at level of oesophageal "jaws" of male, apical view. H, detail of oesophageal "jaws": a, as seen from ventral end; b, as seen in dorsal view; c, dorsal "jaw", apical view. (A to C, and G: 90  $\mu$ m scale; D: 750  $\mu$ m scale; E and F: 50  $\mu$ m scale; H: 30  $\mu$ m scale.)

Right spicule 545 (566-618)  $\mu\text{m}$ , left spicule 564 (570-587)  $\mu\text{m}$  and tail 538 (465-506)  $\mu\text{m}$  long. — *Female* (allotype followed by range of 3 paratypes in parentheses) : Length 10.21 (10.25-10.84) mm. Maximum width 533 (452-480)  $\mu\text{m}$  just anterior to vulva. Buccal cavity 12 (10-11)  $\mu\text{m}$  and oesophageal corpus 163 (167-173)  $\mu\text{m}$  long. Bulb 245 (242-260)  $\mu\text{m}$  long and 245 (238-260)  $\mu\text{m}$  wide. Nerve ring 142 (149-167)  $\mu\text{m}$ , excretory pore 145 (153-160)  $\mu\text{m}$  and vulva 6.63 (6.49-7.08) mm from anterior extremity. Tail 404 (391-436)  $\mu\text{m}$  long. Eggs 88-91 (86-95)  $\mu\text{m}$  wide and 120-123 (113-130)  $\mu\text{m}$  long.

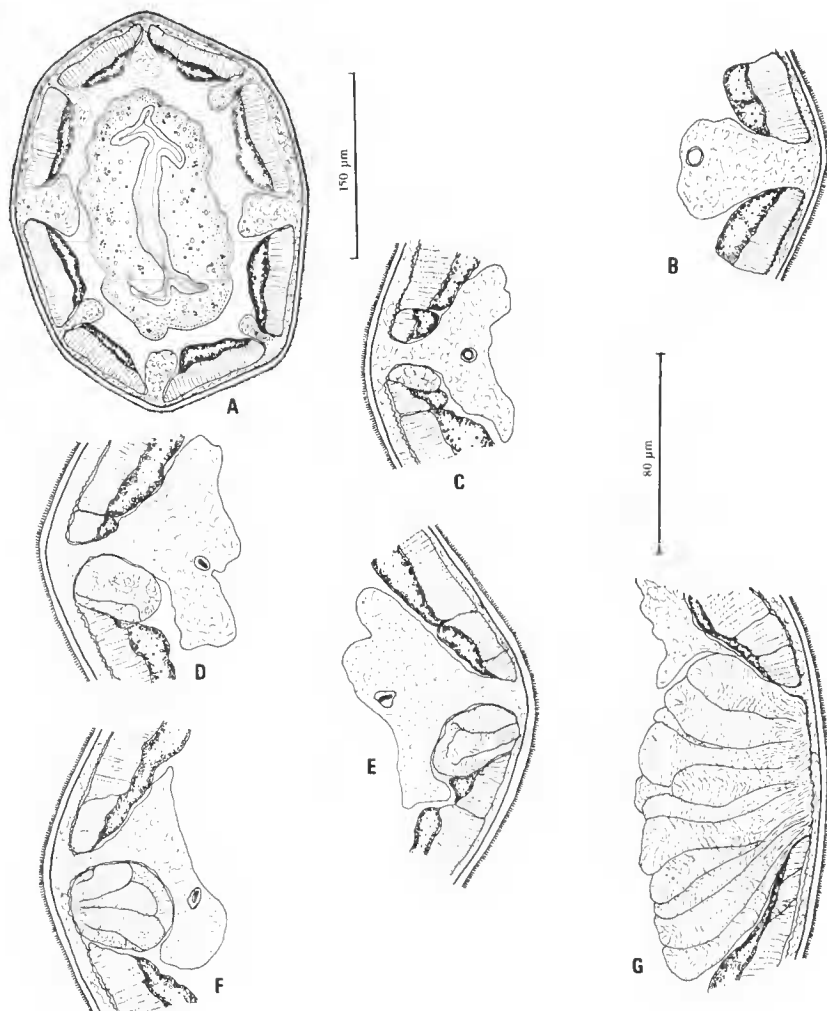


FIG. 3. — *Obainia gabonensis* n. gen., n. sp. A, section through midbody of female showing lateral, median, and submedian hypodermal cords. B to G, sections through lateral field of male taken progressively more posteriorly on body and showing lateral muscle mass. B, near base of oesophagus, lateral muscle mass absent; G, just anterior to flexure of testis. (A, : 150  $\mu\text{m}$  scale; B to G : 80  $\mu\text{m}$  scale.)

## DISCUSSION

*Obainia* is similar to *Rhigonema* Cobb, 1898 : cuticle of the cephalic extremity is divided into a cephalic cap bearing cephalic papillae and a posterior collar bearing amphids ; the buccal cavity is short and simple ; the anterior end of the oesophagus has three toothed cuticular jaw-like structures. The genus presumably evolved from a *Rhigonema*-like ancestor by lateral compression of the cephalic extremity and reduction of the dorsal jaw. Thus, the mouth became dorsoventrally elongate and the dorsal lobe of the cephalic cap became folded giving rise to two small subdorsal lobes. The genus is named after a colleague, Dr. O. BAIN, who brought the host back from Gabon.

An elongate mouth opening has arisen in the South American rhigonematids *Ichthycephalus* and *Paraichthycephalus*. This is clearly an instance of convergence since, in the South American genera, the cephalic extremity is dorsoventrally compressed and the mouth opening is laterally elongate.

*Obainia gabonensis* is characterized by two unusual features : lateral somatic muscle masses apparently formed by coelomyarian subunits and present only in males ; submedian hypodermal cords present only in females.

The significance of the lateral muscle masses is unclear and we have no information on how or when during ontogeny they develop. Contractile portions of somatic muscles in nematodes consist of bundles of longitudinally arranged thick and thin fibres separated by narrow bands containing among other organelles, sarcoplasmic reticulum (HOPE, 1969). Orientation of the banding in the normal somatic musculature of *O. gabonensis* is perpendicular to the body cuticle and thus corresponds to the typical platymyarian pattern. Banding in the lateral muscle masses appears to be oriented parallel to the body cuticle, each subunit consisting of two columns of fibre bundles. It is as if each subunit represents a platymyarian muscle folded longitudinally.

To our knowledge this is the first report of submedian hypodermal cords in a phasmidian nematode. Such cords are relatively common in the Mermithidae and certain free-living aphasmidians (CHITWOOD and CHITWOOD, 1950) but their significance is unknown.

### ***Rhigonema pachybolii* n. sp.**

(Figs. 4 and 5)

Cuticle of cephalic extremity consisting of cephalic cap surrounding mouth opening and posterior collar separated from cap by groove. Four prominent round submedian papillae on cephalic cap and amphids just behind groove separating cephalic cap and collar. Tiny nerve leading towards oral opening from inner edge of each papilla.

Body cuticle posterior to collar with fine striations about 2  $\mu$ m apart each stria with tiny cuticular spines on their posterior border. Spines becoming smaller posteriorly and disappearing well anterior to midbody region.

Nine prominent arcade cells (three dorsal and three on each subventral side) present around anterior end of oesophagus, more evident in females than in males.

Buccal cavity short, subtriangular in apical view. One dorsal and two subventral



FIG. 4. — *Rhigonema pachybolii*, n. sp., male holotype. A, entire worm, lateral view. B, anal region, ventral view. C and D, caudal end in lateral and ventral view. E, caudal end, lateral view, detail. F, oesophageal region, lateral view. G, spicules, ventral view. (A : 500  $\mu$ m scale ; B : 30  $\mu$ m scale ; C and D : 150  $\mu$ m scale ; E and G : 80  $\mu$ m scale ; F : 90  $\mu$ m scale.)

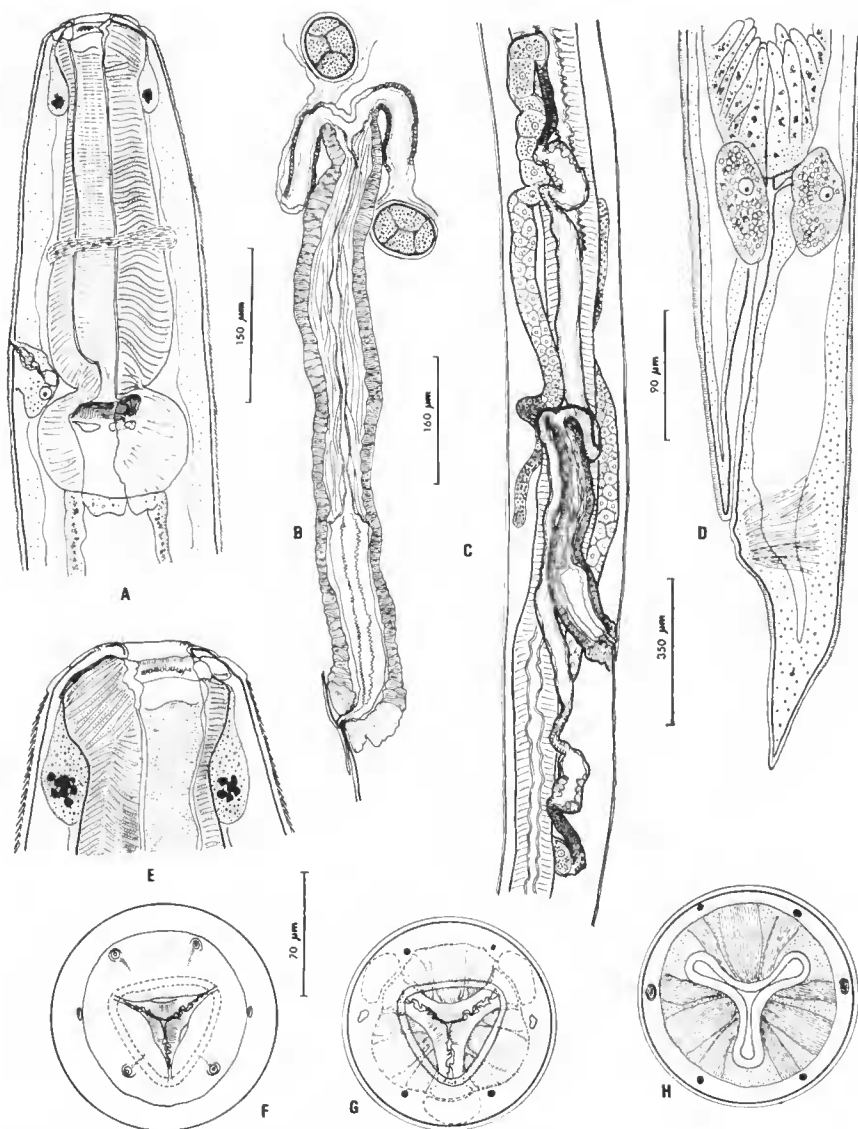


FIG. 5. — *Rhigonema pachybolii* n. sp., female. A, oesophageal region, lateral view. B, vagina, lateral view. C, reproductive system, lateral view. D, caudal end, lateral view. E, cephalic extremity, lateral view. F, superficial apical view. G, optical section at level of oesophageal jaws. H, section just posterior to jaws. (A : 150 µm scale ; B : 160 µm scale ; C : 350 µm scale ; D : 90 µm scale ; E to H : 70 µm scale.)

fleshy lobes forming sides of buccal cavity. Anterior end of oesophagus abutting against one ventral and two subventral plates of thickened body cuticle and with one dorsal and two subventral sclerotized V-shaped toothed jaws. Excretory pore similar to that in *Obainia*.

#### *Holotype male*

Testis running anteriorly, flexing posteriorly well behind oesophagus and emptying into seminal vesicle filled with elongate spermatozoa about 20  $\mu\text{m}$  long. Spicules arcuate, similar and subequal. Gubernaculum poorly sclerotized.

Twenty-five caudal papillae arranged asymmetrically : four subventral preanal on left side ; five subventral preanal on right side ; one median papilla on anterior anal lip ; five subventral and three laterodorsal postanal on right side ; four subventral and three laterodorsal postanal on left side.

Phasmids just anterior to last pair of caudal papillae. Striations becoming less regular on tail and ending as wrinkle like ornamentations similar to those described in *Obainia*. Eight coelomocytes present, arranged *in tandem* on ventral side of body near blind end of testis.

#### *Female*

Didelphic. Amphidelphic. Anterior lip of vulva forming large posteriorly directed flap overhanging posterior lip. Vagina muscular, directed anteriorly expanding into large chamber before dividing into anterior and posterior reproductive horns.

**DIMENSIONS :** *Holotype male* : Length 4.39 mm. Maximum width 206  $\mu\text{m}$  near midbody. Buccal cavity 9  $\mu\text{m}$ , and oesophageal corpus 307  $\mu\text{m}$  long. Bulb 76  $\mu\text{m}$  long and 116  $\mu\text{m}$  wide. Nerve ring 190  $\mu\text{m}$  and excretory pore 283  $\mu\text{m}$  from anterior extremity. Left spicule 295  $\mu\text{m}$ , right spicule 299  $\mu\text{m}$  and tail 175  $\mu\text{m}$  long. *Female* (allotype followed by range of 3 paratypes in parentheses) : Length 5.92 (6.25-6.52) mm. Maximum width 284 (270-288)  $\mu\text{m}$  just anterior to vulva. Buccal cavity 12 (9-10)  $\mu\text{m}$ , oesophageal corpus 363 (346-374)  $\mu\text{m}$  long. Bulb 103 (96-114)  $\mu\text{m}$  long and 148 (129-142)  $\mu\text{m}$  wide. Nerve ring 228 (202-226)  $\mu\text{m}$ , excretory pore 336 (302-334)  $\mu\text{m}$  and vulva 3.58 (3.76-4.06) mm from anterior extremity. Tail 169 (165-179)  $\mu\text{m}$  long. Eggs 95 (80-95)  $\mu\text{m}$  long and 75 (65-70)  $\mu\text{m}$  wide with smooth shell 9 to 10  $\mu\text{m}$  thick.

#### DISCUSSION

*Rhigonema pachybolii* n. sp. is most similar to *R. neyrae* Singh, 1955, from *Thyroglutus malayus* from Lucknow, India. Longitudinal striated thickenings of the cuticular lining of the oesophageal corpus ('baguettes pharyngiennes' of DOLLFUS (1952)) are absent in both species ; in addition, the form of the ovejector, male caudal extremity and spicules are similar in both species. *Rhigonema pachybolii* differs from *R. neyrae* in having 25 rather than 23 caudal papillae and in the fact that these are asymmetrically distributed (13 on right, 11 on left side of body and one median). In addition, *R. neyrae* is larger and has a shorter oesophagus.

Species of *Rhigonema sensu lato* are divided among four genera (*Rhigonema* Cobb, 1898, *Dudekemia* Artigas, 1930, *Haplacis* Railliet and Henry, 1916, and *Ruizia* Travassos and Kloss, 1959) by TRAVASSOS and KLOSS (1960). According to their scheme the present

species would be considered a member of *Dudekemia*, distinguished from *Rhigonema* only by the absence of a vaginal diverticulum. DOLLFUS (1952) noted that it was not known if such a diverticulum exists in *R. brevicolle* Cobb, 1898, type species of *Rhigonema*. He suggested that *Dudekemia* be reduced to subgenus rank until this could be ascertained. However, the same problem exists at the subgenus level and we prefer to consider *Dudekemia* a synonym of *Rhigonema*.

*Haplacis* includes two species, *H. sylvestrii* (type) and *H. modigliani*, described by PARONA (1896) under the genus name *Isacis* (placed in synonymy with *Rhigonema* by CHRISTIE and COBB (1927)). The species have not been redescribed. RAILLIET and HENRY (1916) proposed *Haplacis* for them because they were said to have only one spicule. In all other respects they resemble species of *Rhigonema* and this matter should be reinvestigated.

The three characters suggested by TRAVASSOS and KLOSS (1960) to distinguish *Ruizia* and *Rhigonema* are not workable. The "formaço cuticular umbeliforme" which they considered to be present only in *Ruizia* is, in fact, present in *Rhigonema* (as well as in *Obainia*). In all of these nematodes the cuticle on the anterior extremity is divided into a cephalic cap and collar which overhangs the rest of the body cuticle. In species lacking spines, this overhang is particularly pronounced but the overhang is present in all.

The shape and length of spicules vary considerably in *Rhigonema* and spicules are often not clearly illustrated in descriptions. Spicular morphology may be useful as an auxiliary character but the separation of genera on the basis of this character alone is not prudent. The problem with the use of the vaginal diverticulum as a generic character in this group has already been discussed.

*Ruizia* as presently conceived confuses rather than clarifies the systematics of this group of species and it is here considered a synonym of *Rhigonema*. If this scheme is accepted, *Rhigonema* includes thirty-one nominal species: eighteen from South America (assuming that the host of *R. acuminata* (d'Udekem, 1859) is South American as suggested by ADAMSON (1983)); four from North America; five from Africa; two from India<sup>1</sup>; one each from Australia and New Zealand.

African and Indian species differ from New World and Pacific Island species in that, like *Obainia*, at least two pairs of the postanal papillae are lateral or dorsolateral in position; all caudal papillae in New World and Pacific Island species are subventral or ventral. In this respect *Rhigonema* can be considered as consisting of two evolutionary lines: one in India and Africa (from which *Obainia* arose) and one in the New World and Pacific region. The genus has an essentially Gondwanian distribution and the North American species are probably derived from South American forms.

1. The name *R. raoi* n. sp. is proposed for material referred by RAO (1958) to *R. subtruncatum* Dollfus, 1952. Besides having an Indian rather than South American distribution, *R. raoi* differs from *R. subtruncatum* in having 7 pairs (as opposed to 3) of postanal papillae, two of which are lateral or dorsolateral in position, in having shorter spicules (290-300  $\mu$ m as compared with 350  $\mu$ m) and in having a posteriorly directed vagina.

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